The Orbits of Jupiter and its Galilean Satellites and the Gravity Field of the Jovian System

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In support of the Galileo mission, we have been developing ephemerides of the Galilean satellites based on numerical integrations of their orbits fit to a variety of Earthbased and spacecraft observations. A necessary byproduct of this effort is improved knowledge of the Jovian system gravity field, the orbit of Jupiter, and the encounter trajectories of the spacecraft. Unlike the Galileo Project which operates in the EME-1950 coordinate system, our work is in the International Celestial Reference Frame. Use of this frame permits more precise modelling of the spacecraft and satellite observations. The Earthbased observation set spans the years 1967—2001 and includes: photometric Earthbased astrometry, CCD Earthbased astrometry, satellite mutual eclipses and occultations, and timings of satellite eclipses by Jupiter. The spacecraft observations include: Doppler tracking, radiometric range, very-long baseline interferometry, radio occultations, and optical navigation imaging from Pioneer 10, Pioneer 11, Voyager 1, Voyager 2, Ulysses, Galileo, and Cassini. The Pioneer and Voyager data set is the same as that used by Campbell and Synnott (1985 *AJ* 90, 365). We adjusted the satellite orbits, planet orbit, spacecraft trajectories, and gravity field parameters to fit the observations in a least squares sense. We have determined the following GM values (units of $km^3\ s^{-2}$): (126712764.3 ± 1.5) for the Jovian system, (5959.91 ± 0.02) for Io, (3202.72 ± 0.02) for Europa, (9887.83 ± 0.03) for Ganymede, and (7179.29 ± 0.02) for Callisto. The gravitational zonal harmonics of Jupiter are $J_2 = (14734.9 \pm 0.4) \times 10^{-6}$, $J_4 = (-589.8 \pm 3.8) \times 10^{-6}$, and $J_6 = (27.3 \pm 10.7) \times 10^{-6}$. The GMs and harmonics are consistent with the ones determined by Campbell and Synnott, but their uncertainties are smaller. The results on the satellite gravitational harmonics have appeared in a number of publications: Anderson *et al.* 1998 *Science* 280, 1573; Anderson *et al.* 1998 *Science* 281, 2019; Anderson *et al.* 1998 *BAAS* 30, 826; Anderson *et al.* 1999 *BAAS* 31, 826; Schubert *et al.* 2000 *BAAS* 32, 1046.